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ABSTRACT

The costs, effects, and utility of mathematics instruction supplemented by microcomputer presentations were compared with those of traditional classroom approaches for grades 3 and 5. The study was completed at a single school in a rural area of Saskatchewan, Canada, where two classrooms at each grade level were used in a pretest-posttest design. In both grades, students who received microcomputer instruction scored significantly higher on standard tests of total mathematics achievement and computer literacy than did those who received traditional instruction. Students in all groups scored about the same on a survey of mathematics attitudes. Based on utility ratings obtained from school board members, microcomputer assisted instruction was found to have greater cost utility in both grades. A strong case is suggested for the cost-effectiveness of pairing students on microcomputers placed in classrooms and used to provide adjunct instruction. (8 references) (Author/DB)

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COSTS, EFFECTS, AND UTILITY OF MICROCOMPUTER-ASSISTED INSTRUCTION IN THE CLASSROOM

by

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COSTS, EFFECTS, AND UTILITY OF MICROCOMPUTER-ASSISTED INSTRUCTION IN THE CLASSROOM

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ABSTRACT

The costs, effects, and utility of mathematics instruction supplemented by microcomputer presentations were compared with those of traditional classroom approaches for grades 3 and 5. In both grades, students who received microcomputer instruction scored significantly higher on standard tests of total mathematics achievement and computer literacy than did those who received traditional instruction. Students in all groups scored about the same on a survey of mathematics attitudes. In grade 3 the cost per month of grade placement gain in total mathematics was about $20 per student for microcomputer assisted instruction and $33 per student for traditional instruction. These costs were about $17 and $27, respectively, in grade 5. Based on utility ratings obtained from school board members, microcomputer assisted instruction was found to have greater cost utility in both grades. Given cost results reported here and by Levin, a strong case is suggested for the cost-effectiveness of pairing students on microcomputers placed in classrooms and used to provide adjunct instruction.

INTRODUCTION

The goals of the study reported here were (1) to provide data from a direct, experimental investigation of the costs and effects of microcomputer delivered instruction weighted by the values, or utilities, assigned to its outcomes, and (2) to illustrate a methodology for using these data to inform choices among instructional alternatives. Although the research literature contains an increasing number of studies concerned with microcomputer effectiveness, none was found that combined systematic collection and analysis of data on microcomputer effectiveness, costs, and utilities.

METHOD

This study was conducted in a single school in a rural area of Saskatchewan, Canada. The study was conducted by the superintendent of the district thereby insuring a good degree of experimental control. The school was well suited for comparing the effects of two treatments as there were at least two classrooms of students at each grade level.

The study involved both classrooms of students at each of grades 3 and 5. It used a pretest-posttest control group design. At the beginning of the school year, students were assigned at random to one of the two classrooms at their grade level. In January, all students were given pretests to measure mathematics achievement, mathematics attitude, and computer literacy. One classroom at each grade level was designated as the control group, and the other classroom was designated as the experimental group. The control groups at each grade level (3TI and 5TI) received traditional mathematics instruction. The experimental groups at each grade level (3CAI and 5CAI) received microcomputer assisted instruction using Milliken Math Sequences (ref 1) software.

The CAI instruction was presented using six stand-alone microcomputers that were placed in each classroom. Both treatments were carried out for 71 school days between January and May. The treatment was controlled so that all groups spent about the same amount of time in mathematics instruction. In May, all groups were given posttests to measure

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mathematics achievement, mathematics attitude, and computer literacy. The tests used were: the Canadian Tests of Basic Skills (CTBS), Multilevel Edition, Form 5 (ref 2); Survey of School Attitudes (SSA) -- Form A (ref 3); and Computer Literacy Test, Grade 4 (ref 4). There were 21 students in group 3TI, 20 in group 3CAI, 19 in group 5TI, and 19 in group 5CAI.

The costs of both microcomputer CAI and traditional mathematics instruction were compiled for this study using the "ingredients" method suggested by Levin (ref 5). Cost ingredients included: (1) personnel (teacher salary and benefits, program management, supervision costs); (2) facilities and renovations (classrooms, furniture); (3) equipment and materials (textbooks, microcomputer hardware, microcomputer software); (4) other costs (training, energy). The costs incorporated two annualization factors: (1) lifetime of resources -- a method to account for the expected life of each resource; and (2) interest -- to account for the income on each investment that would have been realized if the funds had been invested instead of being used to purchase the resource. Lifetimes of microcomputer hardware and software were assumed to be 8 and 4 years, respectively.

A cost-utility analysis was carried out to determine the value of each outcome relative to its cost. Following procedures recommend by Stokey and Zeckhauser (ref 6), members of the division board of education were interviewed to determine the relative utility they placed on students' mathematics achievement, attitude toward mathematics, and computer literacy. The cost utility ratio of each treatment was then calculated based on these utilities.

RESULTS

Mathematics achievement was assessed by entering total mathematics scores from the CTBS into two analyses of covariance performed separately for the grade 3 and grade 5 students. Both analyses indicated that the students using microcomputer based instruction scored significantly higher ($p < .05$) on the CTBS post test. Mean grade placement gains in CTBS total mathematics scores are shown for all four groups in Table 1.

Table 8. Total mathematics grade placement gains, costs per student, and costs per month of gain.

Measure	Group 3TI (n=21)	3CAI (n=20)	5TI (n=19)	5CAI (n=19)
Mean Grade Placement Gains in Months	2.86	5.70	4.94	8.89
Cost[a] per student	$95	$113	$132	$148
Cost per Month of Grade Placement Gain per Student	$33	$20	$27	$17

[a]All costs are reported as 1985 US Dollars.

Assessment of attitudes toward mathematics showed higher scores for microcomputer assisted instruction groups than for the traditional mathematics groups in both grades, but neither of these differences were significant.

Assessment of computer literacy showed higher scores for microcomputer assisted instruction groups than for the traditional mathematics groups in both grades. Both of these differences were significant ($p < .05$) and generally due to better performance in areas of computer use and interaction rather than areas concerned with systematic problem solving or judging the impact of computer technology on society.

Cost per student and cost per month of grade placement gain per student are shown in Table 1 for all four groups. The table shows that the per student cost of this 71-day study was $18 greater for the grade 3 microcomputer assisted instruction group than for the grade 3 traditional instruction group and $16 greater for the grade 5 microcomputer assisted instruction group than for the grade 5 traditional instruction group. Assuming students would average 10 minutes per day of microcomputer assisted instruction for a 180-day school year, the per student per year cost of microcomputer assisted instruction in grade 3 would be $46 greater than the cost of traditional instruction. The corresponding additional cost for grade 5 would be $37 per student per year. These costs are substantially less than the per student per year costs (in 1985 dollars) of $250 estimated by Jamison et al. (ref 7) and the $143 estimated by Levin, et al. (ref 8). There are at least two reasons for these differences.

First, the hardware considered by the earlier studies (mainframe timesharing systems) was both more sophisticated and more costly than the stand-alone microcomputers used in this study. Second, the computer approach considered by the earlier studies involved laboratory-based intervention. Costs of providing the laboratory and its staff accounted for about 15% of the total costs estimated by Jamison et al. (ref 7) and about 46% of the total costs estimated by Levin et al. (ref 8). With the adjunct CAI approach used in this study there were no laboratory costs.

The cost per effect ratio found in this study was $192 for grade 3 microcomputer assisted instruction and $206 for grade 5 microcomputer assisted instruction. The similar, and higher, ratio found by Levin et al. (ref 8) was $1192 (in 1985 US dollars) for computer assisted instruction and $286 for peer tutoring, which was the most cost-effective treatment found in their study. The results from the Levin et al. study and ours suggest that combining both approaches by pairing students who are using microcomputer instruction workstations should demonstrate cost effectiveness superior to any single approach considered by either Levin's study or our own. However, systematic empirical investigation of this possibility has yet to be pursued.

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